Nonlin. Processes Geophys. Discuss.,
https://doi.org/10.5194/npg-2018-33-RC2, 2018

Nonlinear Processes in Geophysics
Discussions
Open Access
EGU

Interactive comment on "Exploring the sensitivity of the large-scale atmosphere circulation to changes in surface temperature gradients using a Statistical-Dynamical Atmosphere Model" *by* Sonja Totz et al.

Anonymous Referee #2

Received and published: 31 July 2018

General Comments

In the present paper the authors use a statistical-dynamical model (Aeolus) to analyse the sensitivity of different components of the large scale atmospheric circulation (Hadley cell, jet stream, storm tracks, and planetary waves) to changes in surface temperature. They separate changes in the forcing temperature into global mean, meridional gradient, and zonal gradient. The results indicate a linear dependence of the strength of the Hadley cell, storm track activity and jets on global mean temperature and meridional gradient, with little sensitivity to zonal temperature asymmetries. Plan-

Printer-friendly version

Discussion paper

etary waves appear to be sensitive to all three temperature components. The Hadley cell width shows a nonlinear dependence. The authors compare their findings with other studies.

In general, (i) intermediate complexity models, like the statistical-dynamical model used here, can be of great help investigating particular aspects of the climate system, (ii) a systematic analyses of the sensitivity of the global atmospheric circulation to changes in surface temperature can be an valuable contribution, and (iii) the components chosen by the authors are central to characterize the large scale circulation. Thus, in principle, overall concept and methodology of the study are sound. The paper is relatively well written and structured. However, unfortunately I do not feel that the work provides enough new and valuable information to warrant publication in the present form. So far, it is mostly an evaluation/validation of the Aeolus model illustrating that it shows similar sensitivities as more complex models (and observations). Thus, the study gives confidence to the model, but does not contribute much to the understanding of the climate system. The authors need to point out much clearer what is the particular aim (process, mechanism, etc.) they are focusing on (it seems like it is 'linearity' of response and/or sensitivity to individual forcing components), and, more important, what are new and significant findings which contribute to our understanding of the atmospheric circulation.

Specific Comments (random order)

1) Conclusions: So far, the central/only conclusion appears to be that the results serve as a validation of the model. This, as noted in General Comments, is insufficient to justify publication in my view. Instead, novel findings of the study need to be summarized, and their (potential) implications need to be discussed.

2) Eq.1: At P5L24/25 the authors state that using Eq.1 only the meridional temperature gradient is altered/updated in T1. Perhaps I got something wrong but as far as I understand Eq. 1 the non-zonal component is modified too. For example: for w_T_phi=0 all

temperatures (including, in particular, the zonal asymmetries) are the same as at the equator (=T_EQ(lambda)), and thus, in general, different from T_DJF(lambda). Please clarify.

3) Forcing: As far as I understand, and as it is stated in Sec. 3.2 and 7, the forcing of the simulations are surface temperatures for both land and ocean, but I'm still not sure: According to P4L23 the forcing appears to be sea level temperature (atmospheric temperatures extrapolated to sea level?), while in Sec. 3.1. L5/6 it is stated that the forcing is sea surface temperature only (and specific humidity at the surface). Finally, from the abstract one may infer that the forcing is the whole (3d) temperature field (P1L15-16). This may be homogenized/clarified to avoid confusions.

4) Stationary waves & topography: Since the authors exclude topographic influences (P4L20), I'm wondering if some modification of temperature is involved in regions with high topography (see also 3). In other words: would the model have stationary waves in a w_azonal=0 experiment?

5) Sensitivities: At various places the authors state that sensitivity to meridional gradient is larger than sensitivity to zonal asymmetries (e.g. P8L8/9). However, the authors apply relative change with respect to reference values (by changing the w's). I guess (though I'm not sure) the absolute values of the meridional gradient and of the zonal asymmetries differ, and I'm wondering whether this statement still holds if absolute changes are considered. In Sec. 4.2.3 (planetary waves) L11-15 it is not clear to me at all if relative of absolute changes are meant (i.e. w or the absolute values). Please clarify.

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2018-33, 2018.